Space Weather Technical Forecast

Issued on Saturday, 18 May 2024 at 01:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further G1-G2/Minor-Moderate Geomagnetic Storms likely at first but waning. Chance of M-class flares, and Slight chance of isolated X-class flares throughout. Decreased chance of S1/Minor Solar Radiation storming but Electron Flux likely to rise into the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity returned to Moderate levels following a M7.2 flare at 17/2108 UTC from AR3685, with the next highest a peak C8.7 flare observed at 17/0146 UTC from AR3679. There are currently 12 sunspots on the visible disc, 11 of which are numbered, with AR3684 fading to plage. The largest region on the disc is AR3685 (Ehi/Beta-Gamma), which lies close to the southeast limb. This region is composed of a number of large spots, magnetic looping is visible across the region and as such it remains classed as one large sunspot group. A new region continues to emerge from the southeast limb, just to the north of AR3685, initially classed as a Hax/Alpha type. AR3679 (Eso/Beta-Gamma) is the second largest region, currently approaching the central disc, and has been the source of recent flare activity. AR3683 (Dai/Beta-Gamma) in the southwest is of modest magnetic complexity and continues to show spot development/emergence. The other sunspot regions are generally smaller, simpler and stable or in slight decay.

The M7.2 flare at 17/2108 UTC from AR3685 produced a Type II radio emission with a CME subsequently visible across all imagery. We await coronagraph imagery for full analysis although a significant Earth directed component is though unlikely given the location of the region. No other Earth-directed CMEs were identified in available imagery.

Solar Wind / Geomagnetic Activity: Lingering CME effects persisted through the first half of the period, with a second CME arrival observed by ACE at L1 at 17/1240 UTC. Solar winds initially near background around 370-420km/s but rose sharply to become slightly elevated around 460-490km/s following CME arrival. Density of the solar wind was initially average, but erratically fell to below average levels following CME arrival. The Interplanetary Magnetic Field (IMF), Bt, was at persistently moderate levels initially, and rose sharply following the CME arrival to a peak of around 17nT before slowly reducing. The north-south component Bz was initially moderately positive and remained so following the initial CME arrival with a peak value of 12nT, but subsequently fell to become generally negative to end the period, with a minimum of -15nT. Phi angle was predominantly positive (away from the Sun) initially but became predominately negative (towards the Sun) following CME arrival. Geomagnetic activity was initially at Quiet levels (Kp 1-2), but rose to become Active following CME arrival, with G1 Minor Storm intervals recorded 17/1500-1800UTC and 17/2100-2400 UTC, and a G2 Moderate Storm interval recorded 17/1800-2100UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10 MeV) remained below the S1/Minor Radiation Storm levels, and continued a slow decline. High energy electron flux (greater than 2MeV) observed by GOES16 was at predominantly background levels. The

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associated 24-hour fluence has remained below the Active threshold. Observed fluence at 18/0000 UTC of 2.87e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Continued Low to Moderate activity is expected, with a slight chance of isolated High activity. AR3685 in the southeast disc is considered to be the most likely source for any X-class activity.

Solar Wind / Geomagnetic Activity: Current CME influence is expected to ease through Day 1 (18 May). At this stage no further significant CMEs forecast to interact with Earth during the period. In the absence of further CME enhancements solar winds are expected to slowly from current slightly elevated levels towards background speeds though the period.

Further G1-G2/Minor-Moderate Storm intervals expected at first, before a gradual return to Quiet to Unsettled conditions through Day 1 (18 May) as CME influence is expected to wane. Activity thereafter is expected to be mainly Quiet with Unsettled intervals, although there remains a slight chance of Active to G1 minor Strom intervals throughout given lower than usual forecast confidence.

Energetic Particles / Solar Radiation: Proton flux continues to decline and is expected to remain below S1/Minor storm levels. There is a persistent slight chance of further enhancement however should any large flares occur given the number of sunspot regions of the Earth-facing disc. High energy electron flux reduced to background following CME arrival but a continued rise in flux levels into Day 2 (19 May) onwards is expected although confidence is reduced due to the potential for further glancing CME influence, which may again reduce the observed flux at times. The associated 24 hour fluence is expected to return to a rising trend later Day 1 (17 May) onwards, increasingly likely to approach or cross the Active threshold Days 3-4 (20-21 May).

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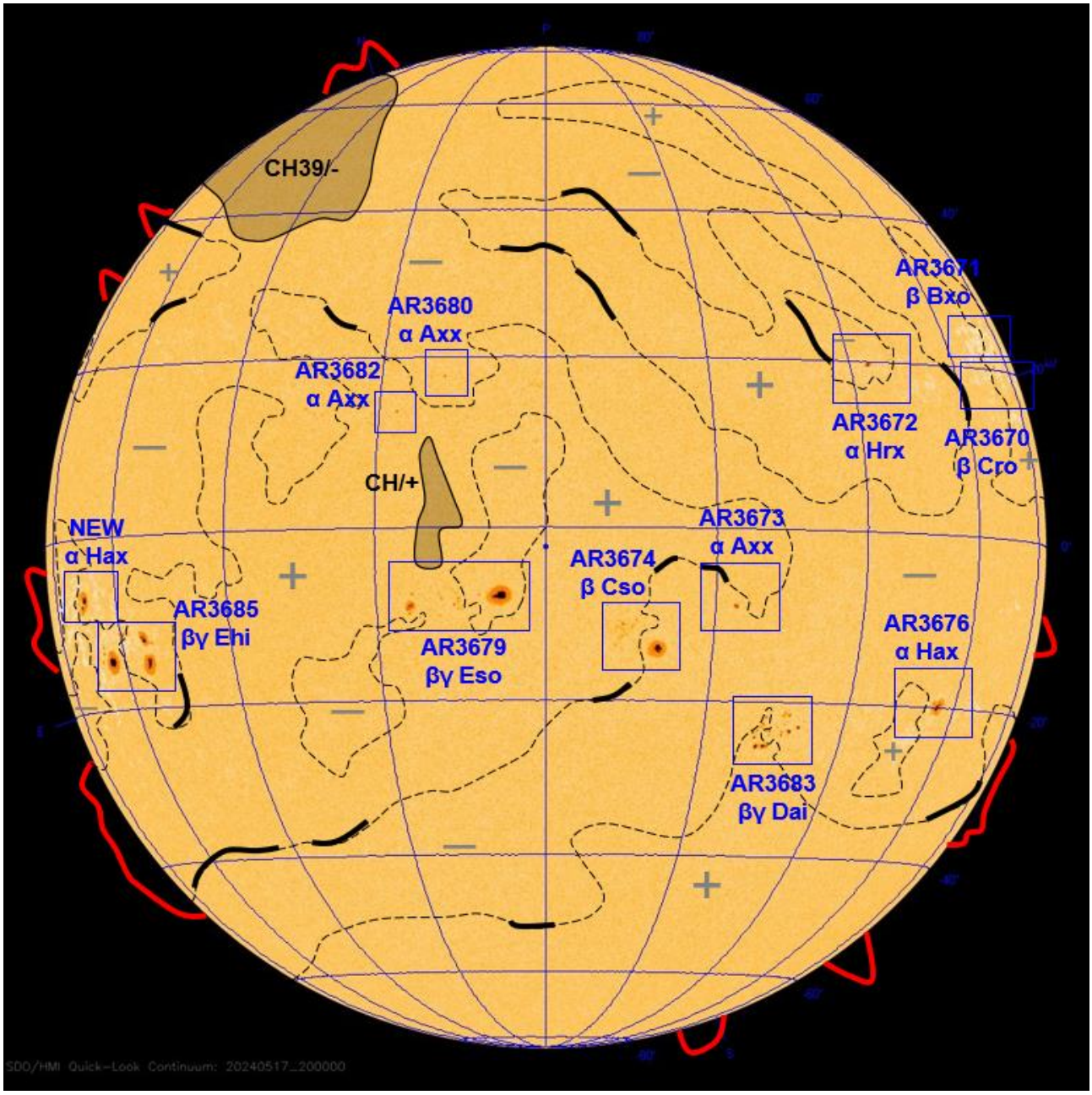
Figure 1. Solar Analysis Valid 17/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
Current CME influence is expected to ease through Day 1 (18 May). This feature is likely associated with a filament eruption observed leaving the northeast disc on 14 May. At this stage no further significant CMEs forecast to interact with Earth during the period, although the number of significant CMEs recorded in recent days makes accurate analysis and modeling of features difficult, reducing confidence in the outlook.

In the absence of further CME enhancements solar winds are expected to slowly from current slightly elevated levels towards background speeds though the period, with no notable coronal holes expected.

Further G1-G2/Minor-Moderate Storm intervals expected at first, before a gradual return to Quiet to Unsettled conditions through Day 1 (18 May) as CME influence is expected to wane. Activity thereafter is expected to be mainly Quiet with Unsettled intervals, although there remains a slight chance of Active to G1 minor Strom intervals throughout given lower than usual forecast confidence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	80	20	10	10
Strong	G3	No	5	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Latest MOSWOC ENLIL for the issue time. Note the high number of significant non Earth directed CMEs, reducing confidence in the forecast given the increased complexity of interactions.

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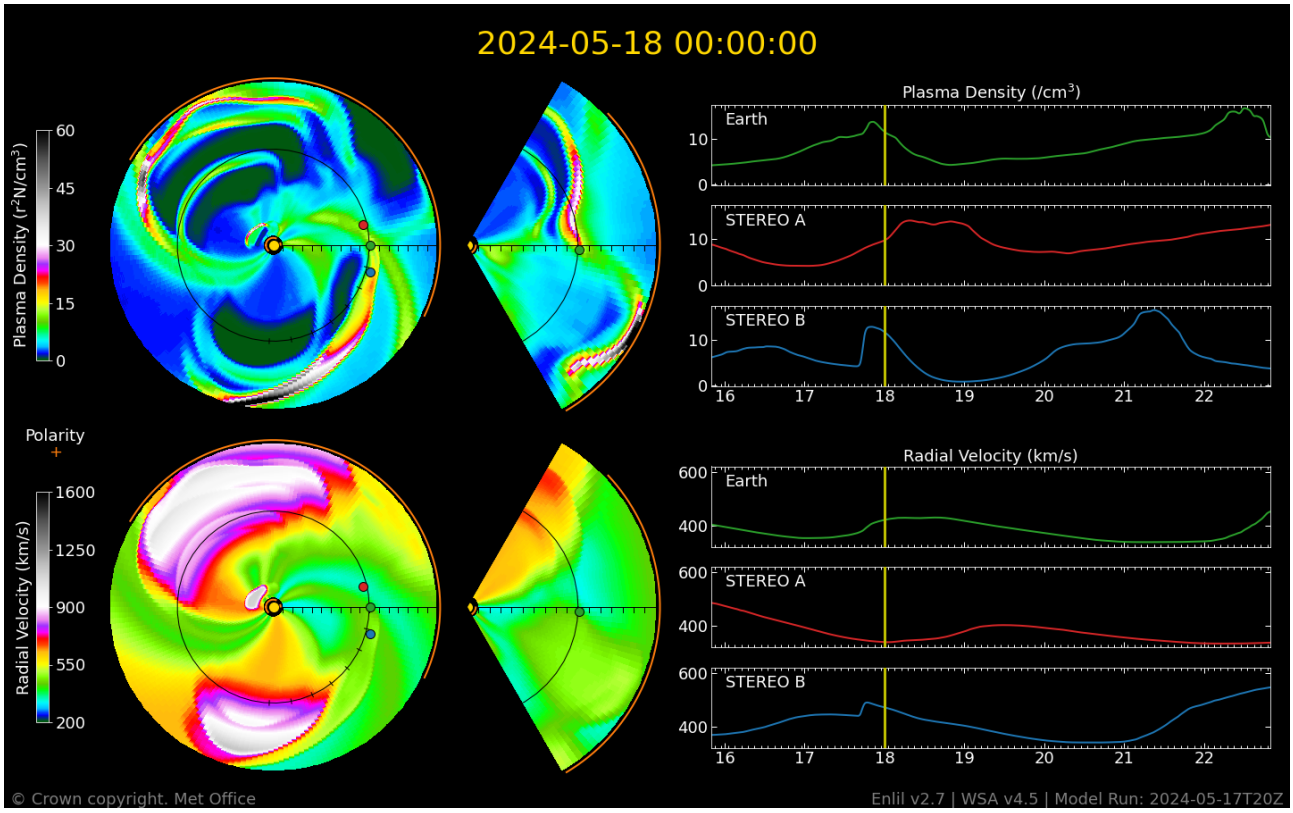

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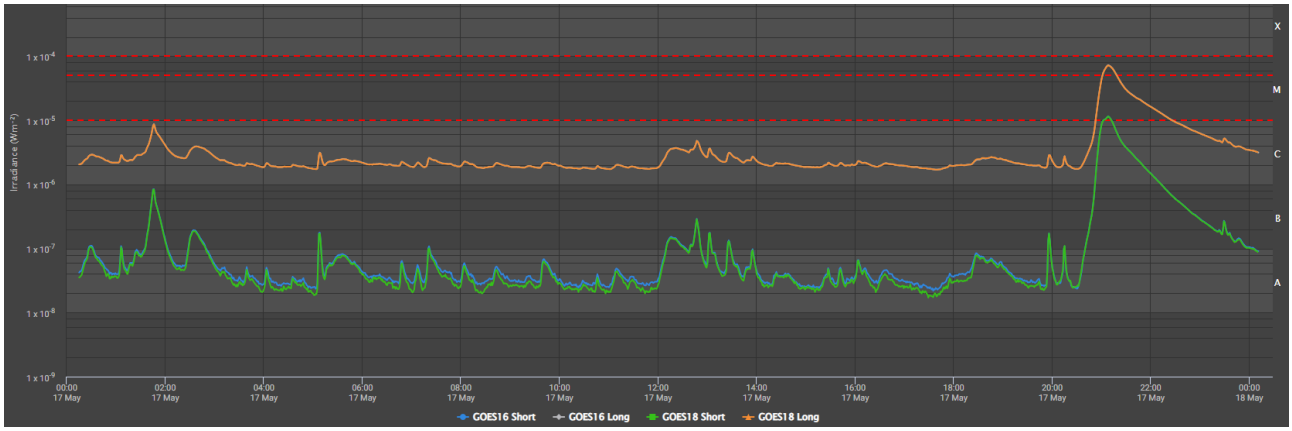
Radio Blackouts - X-Ray Flares:
Continued Low to Moderate activity is expected, with a slight chance of isolated High activity. AR3685 in the southeast disc is considered to be the most likely source for X-class activity, having produced an X2.9 flare on 15 May and the most recent M7.2. Analysis of this region is becoming clearer and some signs of magnetic complexity now visible despite the seemingly fairly stable spot structure. For now an elevated flare risk is maintained for this region throughout the period pending further developments given the history of activity and large amounts of available flux. Recent flare activity has also been observed from AR3679, which is approaching the central disc, with a peak C8.7 flare observed at 17/0146 UTC, with AR3683 also a watch point given recent spot development.

No significant returning regions expected through the period or strongly signaled in far-side sounding data, with all the current flare producing regions remaining on the visible disk. As such, the current flare risks have been maintained through the period pending further developments.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: Latest 24hr GOES18/16 X-Ray trace, dominated by the M7.2 flare from AR3685.



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Solar Radiation Storms - (High Energy Protons):
Recent S1/Minor Radiation Storm conditions were the result of the M6.6 flare of Ex-AR3664 on the southwest limb on 13 May and further contributions from the flaring of this region through 14-15 May, with at least four X-flares occurring.

Proton flux continues to decline and is expected to remain below S1/Minor storm levels. There is a persistent slight chance of further enhancement should any large flares occur given the number of sunspot regions of the Earth-facing disc, although the most likely candidate, AR3685, will remain in a generally unfavorable position for significant proton enhancement through the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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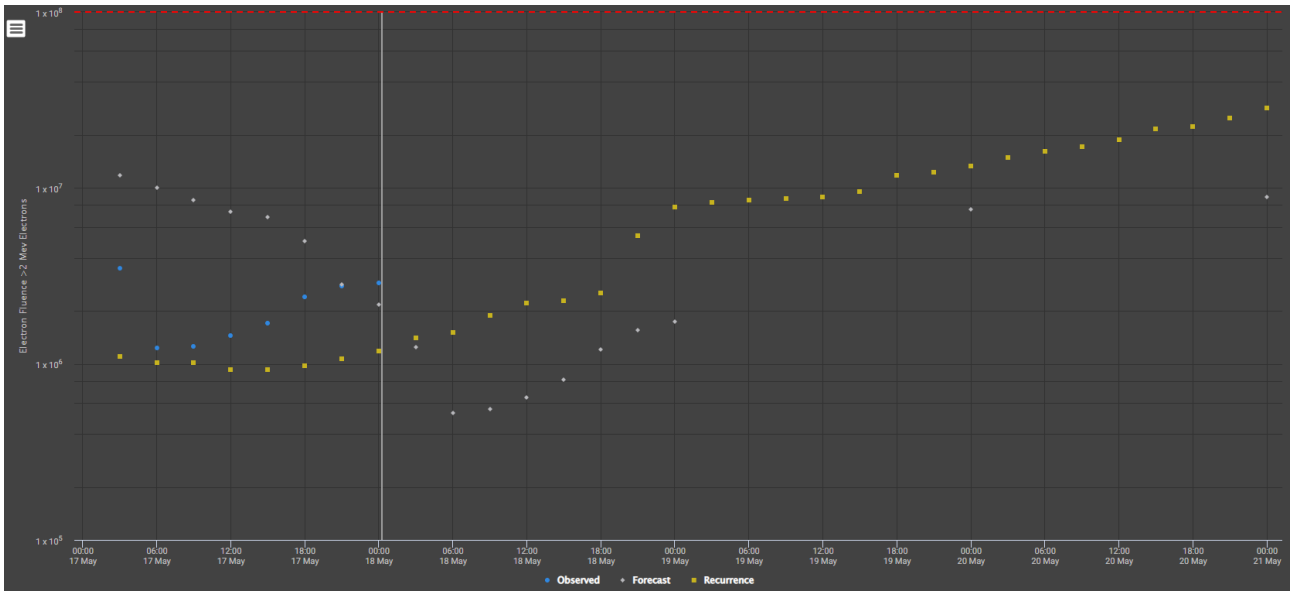
High Energy Electrons Event (≥ 2MeV):
High energy electron flux, as observed by GOES-16 has been at largely background levels following the CME arrival early on 16 May. This trend is most likely to persist in the short term, however there is the potential for electron flux to rise and potentially reach persistently High levels later in the period, with lower orbits having been highly charged by CME arrivals over previous days. A continued rise in flux levels into Day 2 (19 May) onwards is expected although confidence is reduced due to the potential for further glancing CME influence, which may again reduce the observed flux at times.

The associated 24 hour fluence is expected to return to a rising trend later Day 1 (17 May) onwards, increasingly likely to approach or cross the Active threshold Days 3-4 (20-21 May). MOSWOC REFM providing reasonable guidance although perhaps under representing the risk of reaching the Active threshold later in the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	10	40	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Latest MOSWOC REFM model output.



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